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AMINO ACIDS AND CARBOHYDRATES IN VERY ANCIENT DEPOSITS (ACCORDING TO THE EXAMPLE OF THE CYANITE SCHISTS ON THE KOLA PENINSULA)

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Translation of: "Aminokisloty i Uglevody v Drevneyshikh Otlozheniyakh (Na Primere Kianitovykh Slantsev Kol'skogo Poluostrova)," Doklady Akademii Nauk SSSR, Volume 215, Number 2, 1974, pp. 474-477

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16. Abstract

Recently considerable material has been accumulated on the discovery of amino acids and carbohydrates in very ancient layers of the earth. Although these compounds can be produced through non-biologic means, the authors presume that these compounds are of a biological origin even though the deposits are sometimes over 2.6 billion years old.

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AMINO ACIDS AND CARBOHYDRATES IN VERY ANCIENT DEPOSITS (ACCORDING TO THE EXAMPLE OF THE CYANITE SCHISTS ON THE KOLA PENINSULA)[1]

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In the last few years, a considerable amount of experimental material has /474* been accumulated which makes it possible to confirm that algae, bacteria, and simple and complex organic molecules can be preserved in ancient sedimentary rocks in the course of the geologic epochs and can be isolated and identified by modern methods. Thus, algae, bacteria, and other microorganisms have been isolated in sedimentary deposits of the early [1] middle, [2] late [3], and Pre-Cambrian ages, and in this process many of these organisms, when seen from a morphological standpoint, are comparable to or identical with now living Thallophytes [4]. More and more work is being done in studying carbohydrates [5], porphyrins, amino acids, and carbohydrates [6-7], fatty acids, and other organic compounds in modern and ancient rock deposits of the Earth. The importance of such research is growing in connection with the fact that the organic matter being dug up today plays a large role in the geochemical cycle of migration and concentration of chemical elements. The collection of such evidence from various natural geological periods makes it possible to understand the basic mechanisms of the distribution, change, and formation of organic matter throughout the entire course of the geologic history of the Earth. This gives us the possibility of studying the problems of synthesis of organic matter in the early stages of the formation of the Earth and the other planets, makes it possible to follow the evolution of carbon compounds, and makes it possible to shed light on the problem of the course of life on Earth. According to the views of A. I. Oparin [8-9], at the basis of the appearance of living matter are the laws of the evolution of carbon compounds. In order to broaden our knowledge in the area of organic matter of the ancient rocks of

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*Numbers in the margin indicate pagination in the foreign text.

the Earth, with the goal of learning its history, the present research was carried out.

Earlier, we studied samples of black crystalline schists of the Kontiosar scroll (sic) of the Kola Peninsula, which is two billion years old, for its content of amino acids and carbohydrates (7). The research has shown that these schists contain a considerable amount of amino acids and carbohydrates, both free and bound. In our present work, we first investigated the content of amino acids and carbohydrates of a sample of cyanite schist in a series of caves of the Kola Peninsula related to the Pre-Cambrian about 2.6 billion years old.

Stratigraphy and the history of the formation of this cave series are analyzed in a similar manner in works [11] in which one notes a high saturation of cyanite schist in this series with hydrocarbon materials. This series was deposited [11-12] under the conditions of a shallow water basin, in a relatively stable tectonic environment, with deep weathering of the rock in the areas of erosion and with a high degree of sedimentary differentiation while the layers were being formed. Research was conducted [13] on specimens of cyanite schist, and specimens of the cave complex were studied in detail. Studying carboniferous traces with microscopes and electron microscopes made it possible to distinguish /475 four morphologic types of traces of metamorphized organic matter which were proof of sedimentized, synchronous deposit of the very first organic matter on Earth in shale. Sections of the caves were studied for their content of C_{org} (organic carbon), and in this process special attention was devoted to studying the stratified portion of the sections, since the time of the highest carbon content, namely, the clay portion of the sections, served as confirmation of the comparability of Pre-Cambrian and Phanerozoic rocks. The carboniferous content was determined, and for this the hydrocarbons were distinguished from the stratified part of the complex. There were not many of them, and all of them to one degree or another have been oxidized, a phenomenon which characterizes its initial composition. The isotopic composition of the carbon of the graphitic matter in the metamorphized sedimentary rock was studied. The results of the analyses agree well with the results of isotopic research done earlier (1954) for the Pre-Cambrian age.

The methods of the specimens selection, their preparation, sectioning, extraction, washing and the checks on the purity of the reagents and on the purity of the work have been described earlier [6, 7]. The selected specimens were extracted by 80% acidified ethanol for three hours at 40°C in sealed ampules while being shaken constantly. The deposit which settled out after alcohol extraction was submitted to acidic hydrolysis in HCl in sealed ampules at 100° for twenty-four hours. After cleaning, desalinization, and distribution, "bound" amino acids in this hydrolysate were isolated from sugars.

The results obtained are clear evidence of the fact that the cyanite schists of the series of caves on the Kola Peninsula contain in their composition "free" and "bound" amino acids and carbohydrates. In Figure 1 we see the chromatography of the carbohydrates distilled by hydrolysis and alcohol extraction. The alcohol extract ("free" sugars) showed five spots. In the hydrolysate ("bound" sugars) four spots were also detected. The four spots in the hydrolysate are much greater in size and much more intensive in color, a fact which can be explained by their much more complete extraction during hydrolysis.

In Figures 2 and 3, the results of the chromatography on paper and in the amino acid analyzer are presented to establish the amino acid of the alcohol extract ("free" amino acids and the hydrolysate "bound" amino acids). In the chromatogram (Figure 2), "free" amino acids are shown in the form of six spots. These same "free" amino acids on the chromatogram of the amino acid analyzer (Figure 3, I) were determined in the form of 13 amino acids. "Free" amino acids on the chromatogram (Figure 2) appeared as seven spots. On the chromatogram of the amino acid analyzer (Figure 3, II) eleven amino acids were obtained. The /477
results of the research on the composition of "free" and "bound" amino acids which were obtained with the help of chromatography on paper and in the amino acid analyzer, when compared with one another, agree with and supplement one another. Comparing the results obtained on the amino acid analyzer by determining the composition of "free" and "bound" amino acids, one can say that these data are distinguished only by the absence in the "bound" hydrolysates of the amino acid methionine which, as is known, is destroyed by hydrolysis. Likewise the absence of this acid in the chromatogram of the bound acids is not significant,

since in other chromatograms of the amino acid analyzer it is present, although in small quantities. Thus, as a result of the research on the cyanite schists of the series of caves about 2.5 billion years old, it is evident that there are free and bound carbohydrates, and they have been identified as glucose, mannose, and 2 unidentified sugars. The free and bound amino acids are represented by 12 amino acids: aspartic acid, threonnine, serine, glutamic acid, proline, glycine, alanine, valine, isoleucine, leucine, tyrosine and phenylalanine. The free acids, in contrast to the bound acids, have a thirteenth amino acid, methionine.

Figure 1. Chromatogram of "Free" and "Bound" Carbohydrates. I, Traces: 1, lactose; 2, maltose; 3, sucrose; 4, glucose; 5, mannose; 6, ribose; 7, rhamnase; II. "free" carbohydrates: 1, unidentified sugar; 2, glucose; 3, mannose; 4, unidentified sugar.

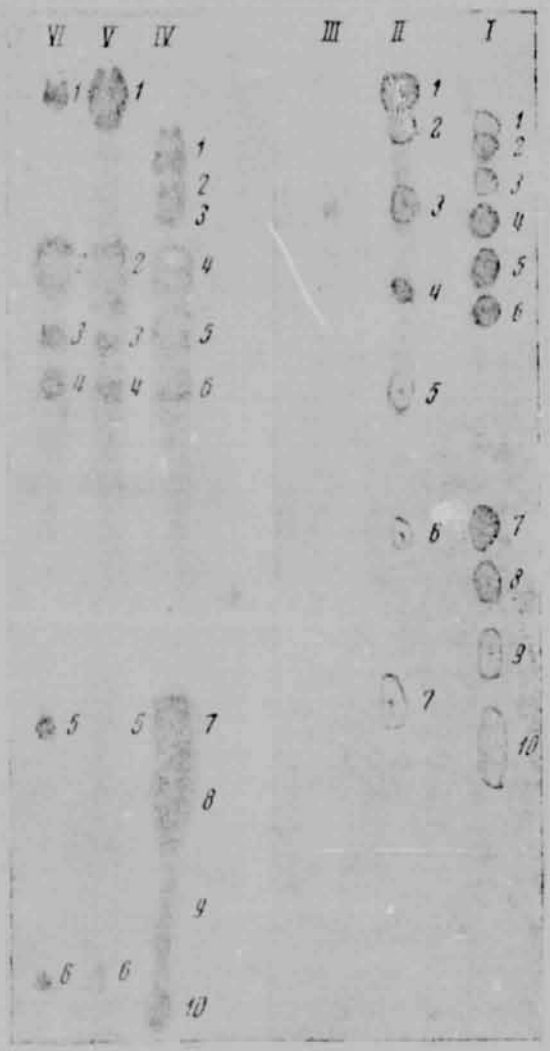

Figure 2. Chromatogram of "Free" and "Attached" Amino Acids. I. Reference spots: 1, cysteine; 2, ornithine; 3, histidine, asparagine, arginine; 4, serine, aminoacetate acids; 5, leucine, threonine; 6, alanine; 7, valine; 8, norvaline; 9, phenylalanine; 10, norleucine; II. "attached" amino acids: 1, unidentified amino acids; 2, lysine; 3, serine; aspartic acid; 4, threonine, leucine; 5, alanine; 6, valine; 7, phenyalanine; III. check on the reagents and purity of the work; IV. Reference spots: 1, cysteine; 2, ornithine, lysine; 3, histidine, aspargine; 4, serine, aminoacetate acid; 5, leucine, trionine; 6, alanine; 7, valine, methionine; 8, norvaline; 9, phenylalanine; 10, norleucine; V. and VI. "free" amino acids: 1, unidentified amino acid; 2, serine, aspartic acid; 3, leucine, threonine; 4, alanine; 5, valine, methionine; 6, phenylalanine.

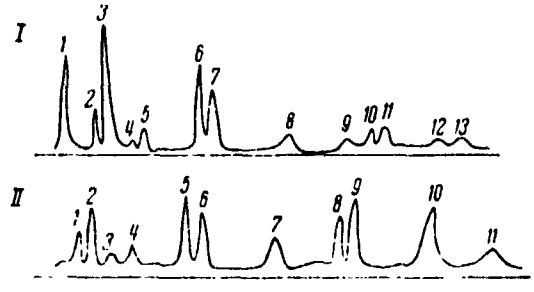

Figure 3. Chromatogram of "Free" and "Bound" Amino Acids. This chromatogram was obtained with the help of an amino acid analyzer from the firm "Hitachi". I. "Free" amino acids: 1, aspartic acid; 2, threonine; 3, serine; 4, glutamic acid; 5, propyne, glycine; 7, alanine; 8, valine; 9, methionine; 10, isoleucine; 11, leucine; 12, tyrosine; 13, phenylalanine; II. "bound" amino acids: 1, threonine; 2, serine; 3, glutamic acid; 4, proline; 5, glycine; 6, alanine; 7, valine; 8, isoleucine; 9, leucine; 10, tyrosine; 11, phenylalanine.

These data agree with the data of a number of Soviet and foreign authors and allow us to assume that molecules of organic matter (amino acids and carbohydrates) can be suspended in the bedrock of the Earth for billions of years. However, on the basis of these results, we still cannot judge definitively the character of the sequence of events which we have found since recently research in non-biological synthesis has shown that it is possible to form organic compounds by non-biologic means, even such complicated ones as porphyrin or isoprenoids, phytain and pristane, which used to be regarded as standards of biologic origin. Nevertheless, based on data from other works [14] which show that complex organic organisms existed more than 3 billion years ago, one can assume that these amino acids are biologic in origin.

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